ef

UNPUBLISHED PRELIMINARY DATA

UNIVERSITY OF PITTSBURGH

GRADUATE SCHOOL OF PUBLIC HEALTH

PITTSBURGH, PENNSYLVANIA 15213

DEPARTMENT OF OCCUPATIONAL HEALTH

August 17, 1964

FACILITY FORM 602

N64-33042 (ACCESSION NUMBER)	(THRU)
6 (PAGES)	1 (CODE)
NASA CR 58872 (NASA CR OR TMX OR AD NUMBER)	15 (CATEGORY)

Grants and Research Contracts
Code SC
Office of Space Sciences
National Aeronautics & Space Administration
Washington, D. C. 20546

Dear Sir:

This is the third quarterly progress report submitted in accordance with the requirements of NASA Contract NASr-169 covering the period from 1 January 1964 through 31 March 1964.

On 17 January 1964 a visit was made to the facilities of Dr. Robert Ledley at the National Biomedical Foundation. Dr. George Moore of the National Bureau of Standards was also visited. Personnel of the University Computer Center as well as of our own group participated. It was subsequently decided that the most efficient and economic disposition of NASA funds would occur if our group, together with personnel from the University Computer Center were to develop the necessary apparatus to transmit information from the microscope to the computer as well as to develop the necessary computer program to deal with the information. We would also devise the specifications for subcontracting of the automatic microscope development. Accordingly, Mr. Russell Ranshaw, a computer engineer on the staff of the Computer Center, was added to the project on a 75% time basis.

OTS PRICE

XEROX $ 1.00 fs

MICROFILM $ .50 mf

In the course of our joint participation in a workshop on cell-counting instrument development on January 24, 1964 at the National Institute of Neurological Diseases and Blindness under the chairmanship of Dr. Louis E. Lippkin, Mr. Kendall Preston, of the Perkin Elmer Corporation, was informed of our decision. He visited our research group on March 26, 1964 in order to aid in the specifying of requirements for the automatic microscope which his company is interested in building for us.

In general, the work which we have completed thus far indicates that this project has three main tasks to be carried out at the University of Pittsburgh. These are: 1) the specification of requirements for the automatic microscope to be built by a subcontractor; 2) the design and construction of the digital equipment required to produce computer-useable picture data; and 3) implementation of suitable computer programs for the analysis of the above data on a digital computer. Some supplemental funding has been sought to procure the necessary equipment in order to carry out these tasks. Progress made on these tasks in this report period is described below.

REPORTS CONTROL No.______

1. The Automatic Microscope

Although exact requirements cannot be defined for the microscope at this time, some preliminary specifications have been laid down, based upon some considerations of the overall system operation. These are:

a. Automatic operation. That is, the operator should be able to stack several slides in the unit and proceed with other work without further contact with the unit.

b. Universal optic interface. It should be possible to place any camera, such as 35 or 70 mm., or the input device for the digital scanner, on the microscope.

c. Coordinate output for use by the digital scanner. It may prove useful to provide information concerning the location of the mitotic cell on the magnetic tape.

d. Focus control. The device should be capable of maintaining acceptable focus over the entire slide. The exact definition of "acceptable" is not yet known.

e. Background density should be controlled in order to provide a uniform image to the digital scanner. This may also place tighter demands upon slide preparation.

f. A repositioning feature may prove useful. That is, given dialed-in coordinates, position the slide to the desired mitotic cell.

Firm demands for the microscope can only be made after considerable additional study of the total system requirements has been made. Additional investigations are to be made by Perkin-Elmer which should provide supplemental data of a nature that will aid in the specification of the microscope unit.

2. The Digital Scanner

The design of the equipment required to convert the results of the microscope into digital data for a computer separates into two sub-areas, the scanner itself and the logical unit which controls it.

The scanner, which is the device to convert the light image of the mitotic cell into digital form, has been investigated. Five possible designs were considered.

a. Rotating mirrors. This design employs a system of spinning mirrors to move the "spot" (smallest examined area) over the picture. It suffers from a changing optical path which causes difficulties in maintaining sharp focus and resolution over the entire field. Also, very stringent mechanical tolerances would be required in order to establish adequate positional accuracy.

b. Spinning disk. This unit utilizes a disk having a 0.006" spiral gap rotating past a 0.006" stationary gap to scan one line. The entire unit moves in a direction perpendicular to the stationary gap to scan the complete picture. Production of the six-mil gaps may tax the state-of-the-art of mechanical engraving. It would be difficult to attach to a microscope, and it would therefore require projection of a photographic image, which may cause loss of detail.

c. The lathe-bed scanner. This is the device employed by the National Bureau of Standards for scanning micrographs and aerial photographs. It requires that an enlargement be made of the picture, which is then mounted on a revolving drum. Set-up time is large, even once the picture is at hand. Scan time is about ten minutes. An adaptation to filmstrips may be possible, but use to directly scan a microscope seems to be infeasible.

d. Flying-spot scanner. This version consists of a cathode-ray tube upon whose face is generated a "raster", which in turn is focused onto the transparent negative. A photo-multiplier, located on the other side of the film, converts the light variations into an analog signal. Ledley's version requires the direct-data channel connection on the IBM 7090 computer. It is inflexible, in that it is limited to filmstrips.

e. ITT Image Dissector. This is a cold cathode camera tube. It acts like a television camera, in that an image is focused onto a sensitive photo-cathode within the tube, which is then scanned by directing the sensing beam via a magnetic deflection system. Resolution in the order of 500 lines per inch over a two inch surface has been quoted. Light sensitivity capable of responding to a microscope image is possible. The cost is similar to that of the flying-spot, but the costly element, the tube itself, has an unlimited life. The unit price includes many sub-components, such as regulated power supplies, which would be required with any scanner.

Of these possible systems thus far studied, the final one seems to offer the best means of scanning the microscope directly, thus reducing turn-around time and cost of operation, while at the same time providing the optimum in resolution, since there is no loss via intermediate optical systems. More study is needed, however, before any definite commitments may be made. Excursions to Fort Wayne to visit ITT and to Brookhaven and Cambridge to observe existing scanners are planned.

The conceptual design of the logical control logic has been done, and the plan appears in Figure 1. Block 1, the scanner, has been discussed above. Block 2, the A-D (Analog to Digital) Converter, has been designed and can be built at any time. Block 3, the control circuitry, is dependent to a large extent upon the balance of the system and desired operating features. Only preliminary specifications have been laid down for it. Block 4, the magnetic tape control, is partially designed. Block 5, the monitor display, is a small storage oscilloscope, available as a stock item from Tektronix. It will display the current picture being scanned and offer a visual check on system performance, focus, etc. Block 6, the magnetic tape drive, has been placed at the temporary disposal of this project by the University of Pittsburgh Computation Center. However, it must be put into operating order. Block 7, the output scope, is a high-intensity oscilloscope equipped with a camera. It will serve as an output device, accepting magnetic tape prepared on a digital computer and producing the results of the chromosome analysis. The oscilloscope is available from Tektronix, and a suitable camera has been seen at the recent IEEE show.

3. The Computer Programming*

Some preliminary experiments have been made which parallel the work of George Moore at NBS. Several deficiencies have been found with this method. One is with the primary matching measurement. P^2/A, gives a measure of the objects general outline, irrespective of the location of junctions within the object (that is, the centromere). In processing a sample "picture", which was prepared by hand on IBM cards, the factor P^3/A was found satisfactory. This factor still suffers from the loss of junction information. Methods of combating this particular deficiency are still being sought.

On March 23, a trip was made to the National Bureau of Standards to have some pictures scanned by the Bureau's device. Investigations of these tapes have not yet been productive. It was discovered, however, that the factor P^3/A does not yield satisfactory matches. Results of this venture may be of little value at this time, because some of the vital details of the mitotic cells have been obscured by the photographic process, such as the increase in density at crossovers of chromosomes.

*Computer work has been sponsored in part by grant number GP-2310 of the National Science Foundation.

In addition to the foregoing discussion, preliminary requirements for the necessary maintainence equipment and supplies have been established. It has also been contemplated that a total system enclosure be designed, complete with air-conditioning.

Respectfully submitted,

Niel Wald

Niel Wald, M.D.
Professor of
Radiation Health

NW:jm